REPORT NO. 77-2-14

3400
SEPTEMBER

DETECTING DECAY WITH THE SHIGOMETER IN SELECTED AREAS OF THE SOUTH

by

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ABSTRACT

In seven separate trials, the shigometer was used to detect discoloration and decay of white and black oaks, shortleaf and pitch pines, black cherry, and hickories. The pattern of resistance readings by the shigometer was often inconsistent with the actual condition of the wood whether decayed, discolored, or sound.

INTRODUCTION

For many years urban and recreation land managers have been interested in detecting decay, particularly as it relates to hazardous trees for the obvious reasons of safety and limiting damage to facilities. Tree hazard rating systems combined factors which were used to arrive at a numerical figure which then decided whether a tree was removed or not (Paine 1971). One of the factors -- probability of failure -- was based on the occurrence of critical weather situations within a 10-year period and external evidence of tree weakness. If one could estimate tree weakness by some evaluation of the internal condition of the tree, probability of failure in Dr. Paine's rating system could be assessed more accurately.

Alex L. Shigo, Forest Pathologist at the Northeastern Forest Experiment Station, has developed a modified ohmmeter, the shigometer, Figure 3, which is designed to detect discoloration and decay (Shigo and Shigo, 1974). With this instrument, seven trials were performed on pines and hardwoods in selected areas of the South. Training was provided by Dr. Shigo at a lecture and field session on the Bent Creek Experimental Forest near Asheville, North Carolina, in September 1975.

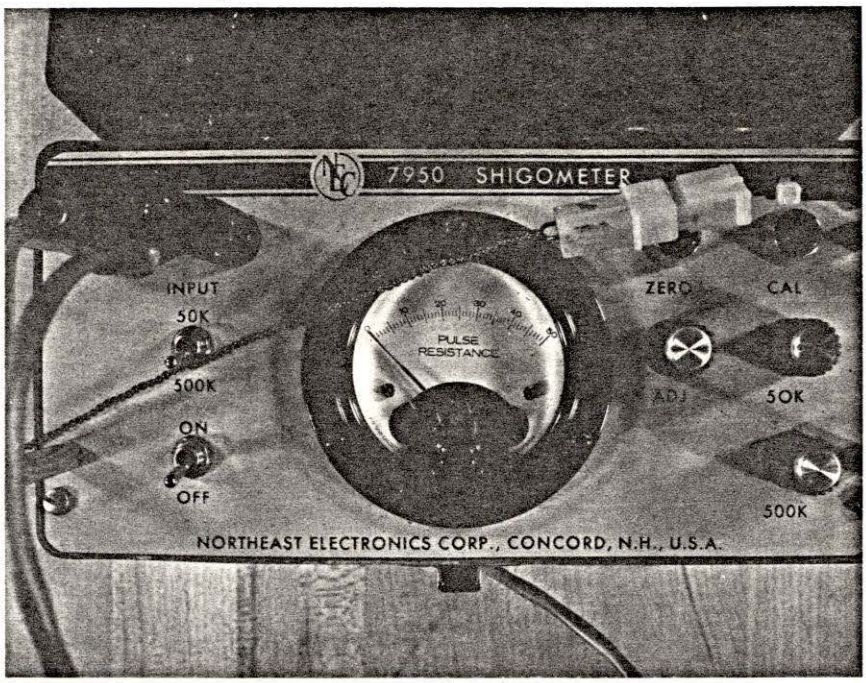

Figure 3. The shigometer, an ohmmeter, used to obtain resistance readings in wood. Also pictured is the insulated copper probe.

MATERIALS AND METHODS

The method for detecting decay is described below. Initially a hole was bored into a tree at a point thought to be decayed. A battery-powered drill or drill powered by a gasoline generator was used. The former was used with small trees, and the latter with large trees. The drill bit was 3/32 inch in diameter and eight or 12 inches long. After drilling, the shigometer was calibrated, and a probe was attached to it. The probe was inserted into the hole, and discoloration and decay were detected by the pattern of readings obtained. Resistance to the electrical current emitted by the shigometer is decreased when the probe tip touches discolored wood, and further decreased with decayed wood. The relative decreases in resistance are the indicators of discoloration and decay. In the middle of the evaluations the shigometer was checked by the manufacturer for accuracy, and no corrections were needed.

Boring and probing required some skill from the field worker. Pines could be bored straight through until the drill chuck was reached. Hardwoods, however, had to be bored a few inches at a time, and then the bit would be retracted. This prevented undue strain placed on the small diameter bit. Boring and retracting, etc., also kept the hole cleaned out so that it could be probed easily. Following retraction flutes of bits should be cleaned out so that drilling would be easier.

When holes in pines were drilled, the probe was cleaned, because false readings occurred when resin was between the probe tips.

TRIAL RESULTS

Daniel Boone National Forest -

Eight large shortleaf pines with conks of the redheart fungus, *Fomes pini* (Thore) Lloyd, were sampled at Sky Bridge picnic area on the Daniel Boone National Forest in Kentucky. Only one tree, which the shigometer had indicated had extensive decay, was felled on July 25, 1974. Actual observations from a cross-section at the 12-foot level revealed 8 to 10 inches of rot in a diameter of 13 inches. Heart rot was present for the entire distance (23 feet) between two conks. The meter had indicated the actual condition reliably. Meter readings with actual observations for this tree and others in this report may be found in the Appendix. Figure 1 illustrates the extensive decay present in this tree. A *Fomes pini* conk is illustrated in Figure 2.

Figure 1. Shortleaf pine cross section metered and cut at a picnic area on the Daniel Boone National Forest in Kentucky.

Figure 2. *Fomes pini* conk on a yellow pine at the Bent Creek Experimental Forest near Asheville, North Carolina.

Bent Creek Experimental Forest -

This trial was performed on 11 shortleaf and pitch pines having redheart conks in January and April of 1975. Five of these were cut for observations. Unfortunately, the same resistance reading corresponded to different conditions in the actual observations. Often a greater than 500 Kilo ohm (K ohm) reading would correspond to advanced decay in some readings, to incipient decay in other readings, and in still other readings to sound wood. Following a drop in the readings, a greater than 500 reading might correspond to advanced decay as would be expected (greater than 500 indicating an air pocket in advanced decay, and air would give infinite resistance to the current), but often it corresponded to sound wood as well. Thus, here the shigometer worked inconsistently.

Kisatchie National Forest -

This evaluation was performed on oaks, sugarberries, and hickories in three mixed stands of hardwoods on two districts of the Kisatchie National Forest and on a southern red oak at a private residence in May and June of 1975. Five trees from the red oak group, the white oak group, five sugarberries (*Celtis laevigata* Willd.), and five hickories were metered and cut. None of the hickories were decayed, and thus meter readings and actual observations for hickories will not be recorded in this report. Meter readings did not drop and were consistently high or low indicating no decay. Lack of decay in hickory corroborated earlier work (Campbell and Verrall, 1956).

Decay and discoloration present in three trees of the red oak group were detected by shigometer readings. External indicators of decay were present with these trees. However, in a fourth red oak relatively low readings of 11 to 20 K ohms indicating decay corresponded to sound heartwood. A fifth decayed oak had a corresponding reading of 65 to 145 with no large relative decreases indicating discoloration only. Readings consistent with the actual condition of the wood can be found under southern red oaks (1), (2), and (5) under the Kisatchie Evaluation in the Appendix. Inconsistent readings are found under (3) and (4).

In the white oak group, decay and discoloration in four trees were consistently indicated by the meter. Soundness in a fifth tree was also indicated by consistently high readings. Large decreases in the readings consistently corresponded to decay. Increases following large decreases often corresponded to discoloration as should be expected. Thus, the meter had given more consistent readings with the white oaks than with the red oak group on this trial.

Consistent readings were rendered on discoloration and decay in two sugarberries, numbers (1) and (2) in the Appendix. In tree number (3) a large increase in the reading corresponded to heartwood. This is inconsistent since a decrease in the reading would indicate heartwood. Large decreases in trees (4) and (5) did not correspond to decay as the readings indicated.

New Orleans - .

The New Orleans Parkway and Park Commission must maintain large sugarberries growing between the streets and sidewalks. The sugarberries which may reach three to five feet in diameter are attacked by a root rot caused by *Ustulina vulgaris*. Fruiting bodies of this fungus may be seen growing at and just above the root collar between ridges on the bark. Often these trees may fall of their own weight even without strong winds. Thus, the need for a method to detect the root and butt rot can readily be seen.

A trial in cooperation with the Commission was conducted on State Street and Valmont Avenue where six trees were metered in May 1975. Equipment difficulties prevented the metering of more trees. Five of these trees were not cut for observations since meter readings did not indicate decay, and data taken on them will not be reported here. Decay present in the sixth tree was inconsistently indicated. Both high and low readings corresponded to the decay. Due to this inconsistency, no more of these large high value trees were metered and cut.

Chickasaw National Recreation Area - 1975 -

This area located at Sulphur, Oklahoma, consists of picnic grounds and group and individual campsites. It is administered by the National Park Service. Formerly it was called the Platt National Park. The evaluation was conducted in June of 1975. Seven oaks were metered in two campgrounds. Only one tree was cut for observations. Again, the meter readings were inconsistent with the actual condition of the wood. Very low readings of 5 to 6 K ohms corresponded to discoloration only. These readings should have corresponded to decay. See appendix for data taken. Although the Recreation Area had decided to cut this tree because of visibly decayed limbs in the top, no more were cut because of the meter's inconsistency on these large high value trees.

Louisiana Forestry Commission, Woodworth, Louisiana -

In this trial a black cherry was metered and cut on September 24, 1976, as part of a training session. While the meter did detect a five inch hollow, it gave readings of 230 and 480 where decay was found. These, of course, are too high. Here, however, the meter's inconsistency was understandable because the decay was dry.

Chickasaw National Recreation Area - 1976

Another trial was conducted in this area on October 27-28, 1976. Seven oaks and one hickory were metered at the Nature Center and on three campgrounds. Two trees were cut. This time the meter was consistent. It detected about 5 inches of a hollow approximately 10 inches in cross-section in one tree. Not all of the hollow was detected because the probe was not long enough. In actuality, sound wood amounted to 4¼ inches and hollow to 10 inches. In the second tree which was felled in a dense stand, only discoloration was found at 9 inches. The meter showed readings of 250 at 8 inches and 110 at 9 inches. Thus, consistency was achieved on both trees.

DISCUSSION

Decayed wood is usually wet and is a site for the accumulation of metallic ions. In theory, the current emitted by the shigometer should find little resistance in such wood. Thus, large relative decreases, not the magnitude of the readings, indicates decay. An attempt was made to obtain ranges of readings for the various tree species and types of internal wood condition. However, this was abandoned due to much overlapping in the readings.

The shigometer in this report operated inconsistently, particularly on the larger trees in the urban and recreation areas. The one shortleaf pine on the Daniel Boone National Forest which the meter read consistently was obviously decayed from external evidence like fire scars and two *Fomes pini* conks. On Bent Creek shortleaf and pitch pines having one conk and no fire scars were read inconsistently by the meter. Meter readings on the small white oaks of the Kisatchie evaluation were read consistently. However, red oaks and sugarberries were inconsistently read. Often the needle fluctuated drastically on the resistance scale with the same reading. As might be expected, the shigometer failed to detect decay in the dry rot of the black cherry during the training session. Lack of water reduces conductivity and thus increases resistance, making readings too high to indicate the decay present. Other types of dry decay such as red brown butt rot caused by *Polyporus schweinitzii* Fr. would also be difficult to detect. Thus, in these trials the shigometer was inconsistent in indicating the actual condition of many trees, and further trials are not planned at this time by our two field offices.

With a consistent meter there is still no set standard, with regard to amount of decay, that governs removal of a tree. One having extensive decay might be kept because it may be the only tree present in the area, and is sorely needed for esthetic value. Another tree having approximately one-half to two-thirds of its cross section decayed may be removed if other sound trees surround it.

LITERATURE CITED

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APPENDIX

Daniel Boone National Forest -

Species - Shortleaf pine
Date - 7/24-25/74
Diameter - at 12 feet - 13 inches
Comments - Hollow with indications of fire at base. Carpenter ants in butt log. Two *Fomes pini* conks present at 12 and 35 feet.
Location - Sky Bridge Picnic Area, Red River Gorge Scenic Area, Daniel Boone National Forest in Kentucky.

Height at Boring	Inches Toward Center of Tree							
	1	2	3	4	5	6	7	7¼
12 feet (conk side)	300 sapwood	245 discoloration	30 ←	35	30 decay	40	40	70 →
12 feet (opposite conk)	320 sapwood	105 decay	85 →	80	55	70	120	65 →
6 feet (conk side)	135 cambial reading	475 sapwood	135 discoloration	75 ←	50 decay →	105	175 discoloration	240 →
6 feet (opposite conk side)	340 sapwood	300 discoloration	155	290 hollow	>500 discoloration	155 ←	125 decay	60 →

Kisatchie National Forest -

Species - Southern red oak (1)
*Date - 5/19/75
Diameter - at five feet - 12.8 inches
Comments - Hollow present was approximately two feet long
Location - Fish Creek and North Tower Road Intersection - Catahoula District - Kisatchie National Forest

Height at Boring	Inches Toward Center of Tree										
	1	2	2½	3	4	4½	5	6	7	7½	8
5 ft.	120 Heartwood	155 Discoloration		175 Hollow	>500 →						
9 in.	430 Sapwood ←	305 Discoloration →		115	120 ←	135	60 Decay →	Hollow	70	>500 Discoloration	280

*Refers to date borings were made.

Species - Southern red oak (2)
Date - 5/13/75
Diameter - at four feet - 10.8 inches
Comments - Fruiting bodies (unknown) present at three feet and five feet from the ground
Location - Same as (1)

Height at Boring	Inches Toward Center of Tree								
	1	2	2½	3	4	4½	5	6	6½
4 ft.	425	305	145	195	26	14	23	12	20
	Sapwood Discoloration →				Decay →				
3 ft.	>500	205	165	85	22	9	10	7	
	Sapwood Discoloration Decay →								

Species - Southern red oak (3)
Date - 5/15/75
Diameter - at three feet - 8.4 inches
Location - same as (1)

Height at Boring	Inches Toward Center of Tree												
	1	2	2½	3	4	4½	5	6	7¼	7½	8	9	9½
2 ft.	4	5 →					6						
	← Decay →												
1 ft.	160	235	320	170	85	75	70	34	20		12	10	11
	Sapwood ←						Heartwood →						

Species - Southern red oak (4)
Date - 5/16/75
Diameter - at 4.5 feet - 5.3 inches
Comments - Fruiting body (unknown) at one foot
Location - Same as (1)

Height at Boring	Inches Toward Center of Tree						
	1	2	2½	3	4	4½	5
1 ft.	145	105	65	110	110		
	← Decay →						
5 ft.	140	>500 →				200	160
	← Decay → discoloration Sapwood						

Species - Southern red oak (5)
Date - 6/2 to 3/75
Diameter - at nine inches - 9.4 inches
Comments - Canker with dark face present at 9 inches
Location - 8425 Fairway Drive, Pineville, Louisiana

Height at Boring	Inches Toward Center of Tree									
	1	2	2½	3	4	4½	5	6	7	7½
1 ft.	135	45	47	37	35		6	9	Heartwood	
	Sapwood		Heartwood		Discoloration					
2 ft.	125	100	130	105	75		43	20		
	← Sound Wood →									
9 in.	>500	17	75	43	80	110	375	185	460	450
	Sapwood ←	Decay →		Heartwood →			Discoloration		Heartwood	

Species - White oak (1)
Date - 5/13/75
Diameter - at 4.5 feet - 8.2 inches
Comments - Polyporus hispidus conk present at 10 feet
Location - Same as Southern red oak (1)

Height at Boring	Inches Toward Center of Tree						
	1	2	2½	3	4	4½	5
1 ft.	345	12	6	5	4	3	
	Sapwood ←			Decay →			
4 ft.	>500	165	6	7	5	4	9
	Sapwood ←			Decay →			

Species - White oak (2)
Date - 5/13 and 16/75
Diameter - at 4.5 feet - 12.7 inches
Location - Same as Southern red oak (1)

Height at Boring	Inches Toward Center of Tree							
	1	2	2½	3	4	4½		
2 ft.	240	>500	210	280	115	>500		
	Sapwood →		Decay	Discoloration		Decay	Hollow	
4 ft.	115	15	80	29	>500			
	Sapwood ←		Decay →		Hollow			

Species - White Oak (3)
Date - 5/15/75
Diameter - at five feet - seven inches
Location - Same as Southern red oak (1)

Height at Boring	Inches Toward Center of Tree							
	1	2	2½	3	4	4½	5	6
5 ft.	175	285	375	305	295	315	355	>500
				Sound Wood				

Species - White oak (4)
Date - 5/16/75
Diameter - at 4.5 feet - 4.9 inches
Comments - Strumella canker present
Location - Same as Southern red oak (1)

Height at Boring	Inches Toward Center of Tree						
	1	2	2½	3	4	4¼	4½
5 ft.	120	4	5	4	8	180	
	Sapwood	←	Decay		→	Sapwood	
4 ft.	135	16	7	305	110		320
	Sapwood	Decay →	Discoloration		Sapwood		Sapwood

Species - White oak (5)
Date - 5/16/75
Diameter - at 4.5 feet - 10.7 inches
Location - On Forest Service Route 155 near the intersection of Forest Service Routes 155 and 120 - Catahoula District - Kisatchie National Forest

Height of Boring	Inches Toward Center of Tree								
	1	2	2½	3	4	4½	5	6	7
2 ft.	360	>500	→		395	285	390	210	225
	Sapwood	Heartwood	→					Discoloration	Heartwood
19 in.	250	315	155	170	18	180	→	270	260
	Sapwood	Heartwood	→	←	Decay	→		Heartwood	
15 in.	180	>500	380	180	8	240	230	220	225
	Sapwood	Hollow	→	Decay →	←	Heartwood	→		

Species - Sugarberry (1)
*Date - May 20, 1975
Diameter - at 4.5 feet - 14.7 inches
Comments - Evidence of root rot

Height at Boring	Inches Toward Center of Tree											
	1	2	2½	3	4	4½	5	6	7	7½	8	9
2 .	125	310	215	265	70	55	25	10	5	9	4	2
	← Sapwood →			← Heartwood			← Decay →					
4 ft.	125	295	265	70	20	15	10	5	5	4	6	
	← Sapwood			Heartwood ←		Decay →						

Species - Sugarberry (2)
Date - 5/20/75
Diameter - at 4.5 feet - 11.6 inches

Height at Boring	Inches Toward Center of Tree									
	1	2	2½	3	4	4½	5	6	7	7½
3 ft.	450	475	>500 →				130	160	65	55	95
	← Sapwood →						← Heartwood →				
15 in.	37	33	14	9	10	9	9	16	23	20	
	← Sapwood →			Decay		Discoloration		Heartwood →			

Species - Sugarberry (3)
Date - 5/20/75
Diameter - at 4.5 feet - 8.2 inches

Height at Boring	Inches Toward Center of Tree							
	1	2	2½	3	4	4½	5	7¼
4 ft.	80	75	70	375	33	28	21	
	← Sapwood →			Heartwood		← Discoloration →		
30 in.	150	420	320	>500	>500			11
	Sapwood	Sapwood →		Hollow →				Decay
		(dense rings)						

* Refers to date borings were made.

Species - Sugarberry (4)
Date - 5/21/75
Diameter - at five feet - 8.4 inches

Height at Boring	Inches Toward Center of Tree							
	1	1.7	2	2½	3	4	4½	5
3 ft.	50		41	50	60	34	40	36
				Soundwood				
18 in.	75	160	42	36	30	37	205	34
	← Soundwood →						Dense Ring →	

Species - Sugarberry (5)
Date - 5/21/75
Diameter - at 4.5 feet - 11.9 inches

Height at Boring	Inches Toward Center of Tree							
	1	2	2½	3	4	4½	5	6
18 in.	>500 →				405	385	130	70
	← Sapwood →						Discoloration	
1 ft.	>500 →				285	105	60	
	← Sapwood →					Discoloration →		

New Orleans Evaluation -

Species - Sugarberry (Celtis laevigata Willd.)
Diameter - approximately 36 inches at one foot
Date - 5/28/75
Comments - Fruiting bodies of Ustulina vulgaris present at base

Height at Boring	Inches Toward Center of Tree									
	1	2	2½	3	4	4½	5	6	7	8
1 ft.	32	200	>500 →		135	75	14	15	13	8
	Cambium ←				Decay →					
15 in.	>500 →				38		35	17		
	Sapwood ←				Decay →					

Chickasaw National Recreation Area Evaluation - 1975 -

Species - Post oak (Quercus stellata Wangenh.)
Diameter - at 4.5 feet - 21.2 inches
Comments - Canker present at four feet
Location - Cold Springs Campground - Campsite #12

Height at Boring	Inches Toward Center of Tree										
	1	.2	2½	3	4	4½	5	6	7	7½	8
4 ft.	255	235	110	235	29	33	37	75	115	13	9
	Sound wood and discoloration present only										
4 ft.	245	180		235	105	6	6	5			
	Sound wood and discoloration present only										

Louisiana Forestry Commission, Woodworth, Louisiana -

Species - Black Cherry
Date - 9/24/76
Diameter - at 4.5 feet - 11 inches
Location - Louisiana Forestry Commission, Woodworth, LA

Height at Boring	Inches Toward Center													
	1	2	2½	3	4	4½	5	6	7	7½	8	9	10	11	11½
4.5 ft.	>500	230		440	480		>500	>500	>500		>500	>500	460		
	Sapwood ←				Dry decay ←				Hollow		→ Sapwood				

Chickasaw National Recreation Area - 1976 -

Species - Chinkapin oak (Quercus muehlenbergii Engelm.)
Diameter - at 4 feet - 14.75 inches
Comments - About 2½ inches of sound wood in advance of the boring.
Tree cut 10/27/76
Location - Rock Creek Campground, Campsite #6

Height at Boring	Inches Toward Center							
	1½	1-3/4	2½	3	4	5	6	7
4 ft.	300	500+	→					
	Sapwood hollow	→						

Species - Red oak (Quercus falcata Michx.)
Diameter - at 4 feet - 14.8 inches
Commetns - Tree cut on 10/28
Location - Cold Springs Campground, Campsite #11

Height at Boring	Inches Toward Center of Tree											
	1	2	2½	3	4	4½	5	6	7	7½	8	9
4 feet	500	390	290	450	330	300	250	240	340	260	250	110
	Sound wood			→							→Discoloration	